

## CLAIMS

Having thus described the invention, what is claimed is:

1. A vapor-liquid contact tray comprising:

a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through the tray deck to interact with the liquid on the upper surface;

at least one can extending upwardly from the tray deck and formed by a perimeter wall, said can being positioned in surrounding relationship to at least some of said vapor passages;

at least one downcomer extending downwardly within said at least one can and providing a passageway for liquid, said downcomer having an upper inlet for receiving liquid and a lower outlet spaced above the tray deck for feeding liquid into the can and onto the tray deck; and

a plurality of deflector blades, positioned above the tray deck within the at least one can and oriented to induce a swirling movement in the vapor ascending within the at least one can,

wherein said vapor passages are selected from the group consisting of sieve holes and valves.

2. The contact tray of claim 1; wherein an area of said tray deck underlying and in vertical alignment with the downcomer outlet is imperforate.

3. The contact tray of claim 1, wherein the vapor passages are sieve holes.

4. The contact tray of claim 1, wherein the vapor passages are valves.

5. The contact tray of claim 1 wherein the deflector blades are attached to the perimeter wall of said at least one can.

6. The contact tray of claim 1, further comprising:

an elevated inlet area above a plane of the tray deck and underlying the downcomer outlet, said elevated inlet area being joined to the tray deck by walls containing vapor passages.

7. The contact tray of claim 6, wherein the elevated inlet area is imperforate.

8. The contact tray of claim 1, wherein the perimeter walls of the at least one can has one or more liquid passages to permit liquid to exit the can, wherein the liquid passages are positioned above a level of the liquid on the surrounding tray deck.

9. The contact tray of claim 8, wherein the liquid passages along intermediate and upper portions of the can perimeter wall comprise two or more rows of triangular-shaped louvers that are oriented with their apex at the bottom.

10. The contact tray of claim 1, further comprising:

a plurality of radially extending guide vanes in the downcomer outlet.

11. The contact tray of claim 1, further comprising:

a sleeve fixed to and upstanding from the tray deck and at least partially overlapping with a lower end of the downcomer, said sleeve providing at least one opening for discharging liquid exiting from said downcomer outlet.

12. The contact tray of claim 1, further comprising:

a horizontally-extending plate positioned across the downcomer outlet having one or more apertures.

13. The contact tray of claim 1, wherein the inlet of the downcomer has a larger horizontal cross section than the outlet of the downcomer.

14. The contact tray of claim 1, including a plurality of said cans positioned in a preselected pattern across said tray deck and wherein said cans are two or more sizes.

15. The contact tray of claim 14, wherein the deflector blades positioned within some of the cans are oriented to induce said swirling movement in one rotational direction and the deflector blades positioned within others of the cans are oriented to induce said swirling movement in an opposite rotational direction.

16. The contact tray of claim 1, wherein the tray deck is comprised of at least two panels joined together along downwardly extending flanges positioned on opposite sides of the panels.

17. The contact tray of claim 1, wherein the perimeter wall of the at least one can comprises two or more segments.

18. A mass transfer column comprising an external shell defining an interior region open to the flow of vapor and liquid streams and a plurality of vapor-liquid contact trays supported in the open internal region, at least one of the vapor-liquid contact trays comprising:

- a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through the tray deck to interact with the liquid on the upper surface;

- at least one can extending upwardly from the tray deck and formed by a perimeter wall, said can being positioned in surrounding relationship to at least some of said vapor passages;

- at least one downcomer extending downwardly within said at least one can and providing a passageway for liquid, said downcomer having an upper inlet for receiving liquid and a lower outlet spaced above the tray deck for feeding liquid into the can and onto the tray deck; and

- a plurality of deflector blades, positioned above the tray deck within the at least one can and oriented to induce a swirling movement in the vapor ascending within the at least one can,

- wherein said vapor passages are selected from the group consisting of sieve holes and valves.

19. The mass transfer column as in claim 18, wherein the vapor passages are sieve holes.

20. The mass transfer column as in claim 18, wherein the vapor passages are valves.

21. A method of intermixing vapor and liquid streams in a mass transfer column having a plurality of vapor-liquid contact trays supported in the open internal region, at least one tray having a tray deck containing a plurality of vapor passages comprising either sieve holes or valves, at least one can having a perimeter wall, at least one downcomer interposed within the can, and a plurality of deflector blades positioned above the tray deck, the method comprising:

(a) flowing a liquid stream across the tray deck of one of the trays toward at least one opening in the tray deck;

(b) directing at least part of the liquid stream into an inlet of the downcomer;

(c) discharging substantially all of the part of liquid stream from the downcomer into the can of the underlying tray deck;

(d) passing a vapor stream upwardly through the vapor passages in the tray deck and into the can without inducing a swirling motion to the vapor stream as it passes through the vapor passages; and

(e) inducing a swirling movement in the vapor stream after it has passed through the vapor passages, wherein the swirling vapor stream causes the liquid in the can to be thrown against and lifted upwardly along an inner surface of the perimeter wall of the can.

22. A vapor-liquid contact tray comprising:

a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of radially extending blades formed in the tray deck to induce a swirling movement in the vapor flowing upwardly through the tray deck to interact with the liquid on the upper surface;

at least one can extending upwardly from the tray deck and formed by a perimeter wall;

at least one downcomer extending downwardly within said at least one can and providing a passageway for liquid, said downcomer having an upper inlet for receiving liquid and a lower outlet spaced above the tray deck for feeding liquid into the can and onto the tray deck;

a plurality of deflector blades, positioned above the tray deck within the at least one can and oriented to induce a swirling movement in the vapor ascending within the at least one can; and

a sleeve fixed to and upstanding from the tray deck and at least partially overlapping with a lower end of the downcomer, said sleeve providing at least one opening for discharging liquid exiting from said downcomer outlet.

23. The contact tray of claim 22, wherein the sleeve is supported by one or one or more legs extending between the tray deck and the sleeve.

24. The contact tray of claim 22, wherein the sleeve is supported by the underlying tray deck.

25. The contact tray of claim 22, wherein the sleeve is closed by an imperforate inlet area and includes discharge openings in the side wall of the sleeve.

26. A mass transfer column comprising an external shell defining an interior region open to the flow of vapor and liquid streams and a plurality of vapor-liquid contact trays supported in the open internal region, at least one of the vapor-liquid contact trays comprising:

- a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of radially extending blades formed in the tray deck to induce a swirling movement in the vapor flowing upwardly through the tray deck to interact with the liquid on the upper surface;

- at least one can extending upwardly from the tray deck and formed by a perimeter wall;

- at least one downcomer extending downwardly within said at least one can and providing a passageway for liquid, said downcomer having an upper inlet for receiving liquid and a lower outlet spaced above the tray deck for feeding liquid into the can and onto the tray deck;

- a plurality of deflector blades, positioned above the tray deck within the at least one can and oriented to induce a swirling movement in the vapor ascending within the at least one can; and

- a sleeve fixed to and upstanding from the tray deck and at least partially overlapping with a lower end of the downcomer, said sleeve

providing at least one opening for discharging liquid exiting from said downcomer outlet.

27. A method of intermixing vapor and liquid streams in a mass transfer column having a plurality of vapor-liquid contact trays supported in the open internal region, at least one tray having a plurality of radially extending blades formed in the tray deck, at least one can having a perimeter wall, at least one downcomer interposed within the can with a sleeve received at the lower end of the downcomer and a plurality of deflector blades positioned above the tray deck, the method comprising:

- (a) flowing a liquid stream across the tray deck of one of the trays toward at least one opening in the tray deck;

- (b) directing at least part of the liquid stream into an inlet of the downcomer;

- (c) discharging substantially all of the part of liquid stream from the downcomer through the sleeve and into the can of the underlying tray deck;

- (d) passing vapor stream upwardly through the vapor passages in the tray deck and into the can; and

- (e) inducing a swirling movement in the vapor stream, wherein the swirling vapor stream causes the liquid in the can to be thrown against and lifted upwardly along the inner surface of the perimeter wall of the can.

28. A vapor-liquid contact tray comprising:

- a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of radially extending angled



blades formed in the tray deck, wherein the leading edges of the angled blades have a shortened horizontal dimension and the angled blades induce a swirling movement in the vapor flowing upwardly through the tray deck to interact with the liquid on the upper surface;

at least one can extending upwardly from the tray deck and formed by a perimeter wall;

at least one downcomer interposed within at least one can and providing a passageway for liquid, said downcomer having an upper inlet for receiving liquid and a lower outlet spaced above the tray deck for feeding liquid into the can and onto the tray deck; and

a plurality of deflector blades, positioned above the tray deck within the at least one can.

29. The contact tray of claim 28, wherein the angled blades are curved.

30. The contact tray of claim 28, wherein the angled blades are punched into a plurality of stacked plates.

31. The contact tray of claim 30, wherein the angled blades are superimposed in contact with each other.

32. A mass transfer column comprising an external shell defining an interior region open to the flow of vapor and liquid streams and a plurality of vapor-liquid contact trays supported in the open internal region, at least one of the vapor-liquid contact trays comprising:

a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of radially extending angled blades formed in the tray deck, wherein leading edges of the angled blades have a shortened horizontal dimension and the angled blades induce a swirling movement in the vapor flowing upwardly through the tray deck to interact with the liquid on the upper surface;

at least one can extending upwardly from the tray deck formed by a perimeter wall;

at least one downcomer interposed within at least one can to provide a passageway for liquid, having an upper inlet for liquid and a lower outlet above the tray deck for feeding liquid into the can and tray deck; and

a plurality of deflector blades, positioned above the tray deck to induce a swirling movement in the vapor ascending into the can.

33. A method of intermixing vapor and liquid streams in a mass transfer column having a plurality of vapor-liquid contact trays supported in the open internal region, at least one tray having a plurality of radially extending blades formed in the tray deck, at least one can having a perimeter wall, at least one downcomer interposed within the can and a plurality of deflector blades positioned above the tray deck, the method comprising:

(a) flowing a liquid stream across the tray deck of one of the trays toward at least one opening in the tray deck;

(b) directing at least part of the liquid stream into an inlet of the downcomer;

(c) discharging substantially all of the part of liquid stream from the downcomer and into the can of the underlying tray deck;

(d) passing vapor stream upwardly through a plurality of radially extending angled blades formed in the tray deck, wherein the leading edges of the angled blades have a shortened horizontal dimension; and

(e) inducing a swirling movement in the vapor, wherein the swirling vapor causes the liquid in the can to be thrown against and lifted upwardly along the inner surface of the perimeter wall of the can.

34. A vapor-liquid contact tray comprising:

a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of radially extending angled blades formed in the tray deck to induce a swirling movement in the vapor flowing upwardly through the tray deck to interact with the liquid on the upper surface;

a plurality of cans extending upwardly from the tray deck formed by a perimeter wall, wherein the cans are two or more sizes;

at least one downcomer interposed within at least one can to provide a passageway for liquid, having an upper inlet for liquid and a lower outlet above the tray deck for feeding liquid into the can and tray deck; and

a plurality of deflector blades, positioned above the tray deck to induce a swirling movement in the vapor ascending into the can.

35. The contact tray of claim 34, wherein the rotational flow in the cans is varied among the cans.

36. The contact tray of claim 35, wherein the rotation flow within each can facilitates the flow of liquid into one or more openings for removing liquid from the tray deck.

37. A mass transfer column comprising an external shell defining an interior region open to the flow of vapor and liquid streams and a plurality of vapor-liquid contact trays supported in the open internal region, at least one of the vapor-liquid contact trays comprising:

a tray deck having at least one opening for removing liquid from an upper surface of the tray deck and a plurality of radially extending blades formed in the tray deck induce a swirling movement the vapor flowing upwardly through the tray deck to interact with the liquid on the upper surface;

a plurality of cans extending upwardly from the tray deck formed, wherein the cans are formed by a perimeter wall, wherein the cans are two or more sizes;

at least one downcomer interposed within at least one can to provide a passageway for liquid, having an upper inlet for liquid and a lower outlet above the tray deck for feeding liquid into the can and tray deck; and

a plurality of deflector blades, positioned above the tray deck to induce a swirling movement in the vapor ascending into the can.

38. A method of intermixing vapor and liquid streams in a mass transfer column having a plurality of vapor-liquid contact trays supported in the open internal region, at least one tray having a plurality of radially extending blades formed in the tray

deck, a plurality of cans having a perimeter wall, at least one downcomer interposed within the can and a plurality of deflector blades positioned above the tray deck, the method comprising:

- (a) flowing a liquid stream across the tray deck of one of the trays toward at least one opening in the tray deck;
- (b) directing at least part of the liquid stream into an inlet of the downcomer;
- (c) discharging substantially all of the part of liquid stream from one or more downcomers into the cans of the underlying tray deck;
- (d) passing vapor stream upwardly through the vapor passages in the tray deck and into the cans;
- (e) inducing a swirling movement in the vapor, wherein the swirling vapor causes the liquid in the cans to be thrown against and lifted upwardly along the inner surface of the perimeter walls of the cans; and
- (f) directing the rotational flow within each can to facilitate the flow of liquid into one or more openings for removing liquid from the tray deck.